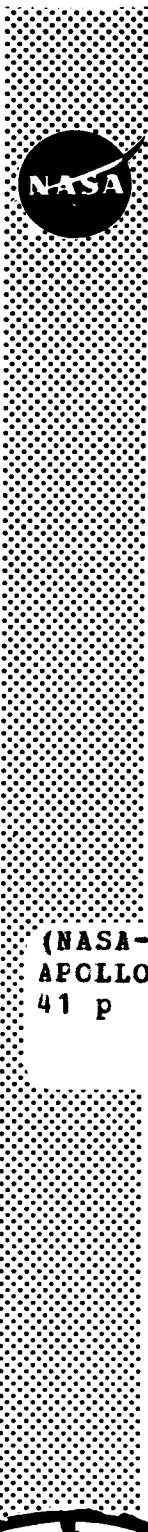
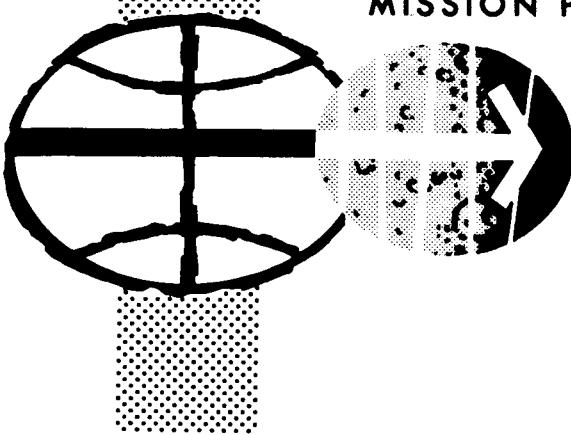


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FIG. 3

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November 25, 1968

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PREFLIGHT INFORMATION

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Lunar Mission Analysis Branch

MISSION PLANNING AND ANALYSIS DIVISION

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PROJECT APOLLO

RTCC REQUIREMENTS FOR APOLLO 8:
PREFLIGHT INFORMATION

By Rocky D. Duncan
Lunar Mission Analysis Branch

November 25, 1968

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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RTCC REQUIREMENTS FOR APOLLO 8:

PREFLIGHT INFORMATION

By Rocky D. Duncan

SUMMARY AND INTRODUCTION

This document presents the preflight data requirements for direct support of the RTCC programs for the Apollo 8 mission. Also included in this document are the most current definitions of the data required for Missions E, F, and G. Therefore, some of the preflight data requirements are not applicable to Apollo 8. This information applies only to those processors formulated by the LMAB. The processors for which preflight information has been defined are:

1. TLI processor.
2. MCC processor.
3. Return-to-earth processor.
4. LOI processor.
5. Powered-flight processor.

SYMBOLS

LLS	lunar landing site
LMAB	Lunar Mission Analysis Branch
LOI	lunar orbit insertion
LOPC	lunar orbit plane change
LPO	lunar parking orbit
MCC	midcourse correction

MPT	mission planning table
RTCC	Real-Time Computer Complex
TEI	transearth injection
TLI	translunar injection
TLMC	translunar midcourse correction

TRANSLUNAR INJECTION AND MIDCOURSE CORRECTION PROCESSORS^a

This section describes the parameters, coefficients, and constants associated with the TLI and MCC processors.^a Most of the preflight data defined in this section is used by both processors; consequently, both processors are treated as a single entity. Definitions of the individual parameters and constants are presented in table I.

The TLI and MCC processors require the largest share of the preflight data requirements. Most of these requirements are the parameters which vary with launch azimuth, injection opportunity, and launch day across a monthly launch window. These numbers are dependent and independent variables which constitute all the first guesses and other numbers required to fly the mission. Because of the large number of parameters required, it has been decided to provide this data to IBM on tape.

Three basic assumptions were made in determining the size of the pre-flight data tables generated from the tape.

1. A 26° band of launch azimuths.
2. Three injection opportunities per launch day.
3. A maximum number of five launch days per month.

These assumptions are assumed to represent a worst case. Using these assumptions, one can determine the maximum amount of storage spaces allotted in the RTCC once the number of parameters, constants, and coefficients for a mission have been determined. If a mission is planned with greater than a 5-day launch window (such as Mission C', alternate 1, currently being considered), then only 5 days of data will be stored in the computers at one time. A new data block could be loaded at any time if launch should slip.

^aThe formulation for the RTCC TLI and MCC processors is described in references 1 and 2.

The tape quantities were first punched on cards by the LMAB and then a card-to-tape process was used with IBM equipment. This is to avoid the difficulty of the differences in tapes generated by IBM and UNIVAC tape drives. The punched-card format and the order of the parameters are shown in table II. For each launch azimuth and injection opportunity, there is a data set on tape consisting of all the parameters required to fly that particular mission. The data sets will be ordered on the cards as follows:

1. Launch day.
2. Launch azimuth.
3. Second opportunity.
4. First opportunity.

The rest of the preflight data (table III) which does not vary with launch day is provided by written transmittal.

The tapes for the December and January launch windows were delivered on September 4, 1968.

RETURN-TO-EARTH PROCESSOR

The return-to-earth processor determines the maneuver required to produce trajectories which return to earth using state vectors in either moon or earth reference. The return-to-earth processor is described in references 3 and 4. Table IV defines the constants, coefficients, and numbers associated with this processor. These preflight data requirements can be functionally categorized as follows.

1. General constants.
2. Generalized iterator constants.
3. Guidance and targeting constants.
4. Conic subprocessor constants.

The preflight data for Mission C', alternate 1, are presented in tables V, VI and VII.

LUNAR ORBIT INSERTION PROCESSOR

The LOI targeting processor computes several impulsive maneuvers to transfer from an approach hyperbola to a lunar parking orbit. A description of the lunar orbit insertion processor can be found in reference 5. These maneuvers transfer the spacecraft to different LPO's (such as an LPO with the minimum LOI ΔV or an LPO nearest the desired LPO). The flight controller selects the desired maneuver and transfers it to the MPT where the powered-burn targets are computed and the guidance is selected.

The preflight data requirements for the LOI processor are presented in table VIII. The actual values are presented in table IX. It should be noted that most of the LOI processor data requirements are contained in the MCC data tables.

POWERED-FLIGHT PROCESSOR

This section describes the parameters and constants associated with the powered-flight processor (ref. 6). The powered-flight processor simulates thrusting maneuvers in the RTCC. The associated parameters and constants are principally the guidance constants and targeting parameters associated with the iterative guidance equations and the hypersurface, respectively.

Since some of the powered-flight processor preflight data varies with launch azimuth, injection opportunity, and launch day, it was decided to provide this data on tape. This is convenient since this data is provided to MSC by MSFC in the launch vehicle PRESET tape.

LMAB will verify the numbers on the PRESET tape and generate cards for delivery to IBM. A card-to-tape process will be used to generate an IBM tape.

Table X defines all of the parameters and constants used by the powered-flight processor. Table A-I of the appendix presents the format of the PRESET tape and table A-II the format for the cards delivered to IBM. This card format allows for up to a 10-day monthly launch window.

At the time of this writing, most of the Mission C', alternate 1 presettings have been delivered to IBM for the December launch window.

TABLE I.- DEFINITION OF PARAMETERS AND CONSTANTS
ASSOCIATED WITH THE TLI AND MCC PROCESSORS

No.	Parameter or constant	Processor utilizing parameter		Parameter or constant on tape	Definition
		TLI	MCC		
1	$T_{LI\ ign}$	X		Yes	Ground elapsed time of translunar injection ignition.
2	δ	X		No	Declination of target vector for alternate missions.
3	σ	X		No	Perigee ring half-angle for alternate missions.
4	$T_{max\ sea}$		X	No	Maximum G.m.t. of pericynthion due to sun elevation constraints.
5	$T_{min\ sea}$		X	No	Minimum G.m.t. of pericynthion due to sun elevation constraints.
6	γ_{loi}		X	Yes	Flight-path angle at lunar orbit insertion initiation.
7	$\Delta\psi_{loi}$		X	Yes	Change in azimuth at lunar orbit insertion.
8	H_{pc}	X	X	Yes	Height of pericynthion.
9	ϕ_{pc}	X	X	Yes	EMP latitude at pericynthion.
10	λ_{pc}	X	X	Yes	EMP longitude at pericynthion.
11	GMT_{pc}		X	Yes	G.m.t. time of pericynthion from epoch.
12	ΔT_{lls}		X	Yes	Flight time from lunar orbit insertion to first pass over lunar landing site.
13	T_{lo}		X	Yes	Total time spent in lunar orbit.
14	ϕ_{lls}		X	Yes	Selenographic latitude of the lunar landing site.
15	λ_{lls}		X	Yes	Selenographic longitude of lunar landing site.
16	R_{lls}		X	Yes	Radius of the lunar landing site.
17	ψ_{lls}		X	Yes	Selenographic azimuth over the lunar landing site.
18	$I_{fr(max)C}$	X	X	No	Conic inclination of the free-return trajectory + ΔI_{fr} .
19	$I_{fr(max)I}$			No	Integrated inclination of the free-return trajectory + ΔI_{fr} .

TABLE I.- DEFINITION OF PARAMETERS AND CONSTANTS
ASSOCIATED WITH THE TLI AND MCC PROCESSORS - Concluded

No.	Parameter or constant	Processor utilizing parameter		Parameter or constant on tape	Definition
		TLI	MCC		
20	ΔV_{tei}		X	Yes	Change in velocity at TEI (scalar).
21	$\Delta \psi_{tei}$		X	Yes	Change in azimuth at transearth injection.
22	T_{te}		X	Yes	Time from transearth injection to reentry.
23	Rnty Rng		X	No	Earth relative reentry range
24	Rnty Δt		X	No	Delta t from reentry to landing.
25	h_{rtny}	X	X	No	Height at reentry for free return.
26	γ_{rtny}	X	X	No	Flight-path angle at reentry.
27	I_{pr}		X	No	Maximum inclination for powered return.
28	λ_{ip}		X	No	Longitude of earth impact point.
29	$T_{tl} \text{ min dps}$		X	No	Minimum translunar flight time for DPS abort.
30	$T_{tl} \text{ max dps}$		X	No	Maximum translunar flight time for DPS abort.
31	$m \left\{ \begin{array}{l} \\ n \end{array} \right.$				Number required to compute the CSM plane change prior to LM ascent.
32			X	No	
33	T_{biaseo}		X	No	Bias time for elliptical lunar parking orbit.
34	V_{pcynlo}		X	No	Velocity at pericynthion of the elliptical lunar parking orbit.
35	I_{fr}		X	Yes	Inclination of free-return.
36	Δt_{ndcir}		X	No	Delta t from the LPO node to circularization in the final LPO.
37	H_{pc}		X	No	Height of pericynthion relative to the landing site of elliptical lunar parking orbit.
38	H_{ac}		X	No	Height of pericynthion relative to the landing site of elliptical lunar parking orbit.

TABLE II.- FORMAT FOR TLI AND MCC TAPE

Card no.	1 - 17	18 - 34	35 - 51	52 - 68	69 - 80	Column
1	341	1	0.108E+03	P	693411108P1	
2	(Day)	(Opportunity)	(Launch ψ)	(Window)		(Identification ^a)
3	(ϕ_{pc})	(λ_{pc})	(H_{pc})	(g.e.t. of TLI)	(Identification ^a)	693411108P2
4	($\Delta\Psi_{1oi}$)	(γ_{1oi})	(T_{1o})	(ΔT_{1ls})		(Identification ^a)
5	0.7253621E+02	0.10300832E+01	0.45056623E+02	0.938E+02		693411108P5
6	(ψ_{1ls})	(ϕ_{1ls})	(λ_{1ls})	(R_{1ls})		(Identification ^a)
7	($\Delta\Psi_{tei}$)	(ΔV_{tei})	(T_{te})	(I_{fr})		(Identification ^a)
8	108.3E + 03 (G.m.t. of pc)	RESERVED FOR EXPANSION				

^aThe identification number has the following parts:

Year	693411108P1	Card number
Day		Injection window
Opportunity		Launch azimuth

TABLE III.- VALUES FOR VARIABLES NOT FOUND ON TAPE^a

Variable	Value
δ	0.0 deg
σ	7.5 deg
$T_{\max \text{ sea}}$	N.A.
$T_{\min \text{ sea}}$	N.A.
$I_{fr(\max)C}$	75 deg
$I_{fr(\max)I}$	90 deg
H_{rnty}	400 000 ft
Rnty Rng	1350 n. mi.
Rnty Δt	832 sec
γ_{rtny}	- 6.48 deg
I_{pr}	40 deg
λ_{ip}	165 deg W
$T_{tl \min \text{ dps}}$	N.A.
$T_{tl \max \text{ dps}}$	N.A.
m	1
n	0
T_{biaseo}	.332 hr
V_{pcynlo}	5480.0 fps
Δt_{ndcir}	4.3 hr
H_{pc}	60 n. mi.
H_{ac}	170 n. mi.

^aN.A. = not applicable to C'.

TABLE IV.- RETURN TO EARTH ABORT PROCESSOR CONSTANTS TAPE LIST

Variable symbol	Variable definition
(a) General constants	
e_{LIM}	Eccentricity limit for EFCUA.
MD_{MAX}	Maximum miss distance used in the trade-off displays.
ΔMD	Miss distance increment used in the trade-off displays.
$R_A MAX$	Abort radius limit for the EFCUA solution in the FCUA mode of the earth phase logic.
T_{ARMIN}	Absolute minimum acceptable flight time from abort to reentry.
(b) Generalized iterator constants	
Tol_j $j = 1, 6$	Dependent variable tolerances.
AVO, BVO	The two constants used to determine the minimum and maximum value for $ \Delta V $ in the optimise mode: Minimum = Maximum = MAX [AVO, (conic value) - BVO]
$STPZ_j$ $j = 1, 10$	The stepsizes for the independent variables.
$IWGT_j$ $j = 1, 11$	The independent variable weights.

TABLE IV.- RETURN-TO-EARTH ABORT PROCESSOR

CONSTANTS TAPE LIST - Continued

Variable symbol	Variable definition
(c) Guidance and targeting constants	
C_{NOMC}	Nominal value of CM computer guidance parameter C.
C_{NOML}	Nominal value of LM computer guidance parameter C.
R_{TSPH}	Radius of the MSI used by the onboard guidance computer.
TB_{SPS}	Maximum burn time for the SPS engine with no iteration in RTED.
TB_{DPS}	Maximum 10 percent thrust level burn time for the DPS engine with no iteration in RTED.
β_{LTST}	Limiting value of flight-path angle between \bar{R} & \bar{V} for solutions from Lambert's problem subroutine with the Lambert's guidance.
ΔT_{LTG}	Time increment used in lunar reference to generate Lambert target vectors.
ϵ_{TG}	Lambert's guidance target vector bias angle.
η_{ATG}	Alternate transfer angle to Lambert's guidance target vector in earth reference.
η_{MTG}	Transfer angle to Lambert's guidance target vector in moon reference.
(d) Earth-centered subprocessor	
δT_z	Landing time tolerance for input landing time in the AST discrete solution option.
$a \left. \begin{matrix} \\ b \\ c \end{matrix} \right\}$	Coefficients for the landing time limit function.

TABLE IV.- RETURN-TO-EARTH ABORT PROCESSOR

CONSTANTS TAPE LIST - Concluded

Variable symbol	Variable definition
(d) Earth-centered subprocessor - Concluded	
T_{RZAVE}	Average flight time from reentry to landing.
η_{RZAVE}	Average down-range angle from reentry to landing.
(e) Moon-center subprocessor	
ΔT_z	Value of the maximum trip time whenever the maximum landing time is not input for the FCUA option of the AST.

TABLE V.- VALUES FOR GENERAL CONSTANTS AND
GUIDANCE AND TARGETING CONSTANTS

Variable	Value
e_{LIM}	0.85
MD_{MAX}	400 n. mi.
ΔMD	100 n. mi.
R_{AMAX}	140 000 n. mi.
T_{ARMIN}	20 min
C_{NOMC}	0.5
C_{NOML}	0.0
R_{TSPH}	64 373 760 m
TB_{SPS}	15 sec
TB_{DPS}	150 sec
β_{LTST}	2°
ΔT_{LTG}	2 hr
ϵ_{TG}	15°
η_{ATG}	215°
η_{MTG}	160°

TABLE VI.- VALUES FOR GENERALIZED ITERATOR CONSTANTS

Constant tape symbol	Associated iterator variable	Value
Tol ₁	h_R	0.03 n. mi.
Tol ₂	Ψ_R	2 deg
Tol ₃	ϕ_Z	0.25 deg
Tol ₄	λ_Z	0.01 deg
Tol ₅	γ_R	0.01 deg
Tol ₆	T_{AZ}	8 hr
AVO	$ \overline{\Delta V} $	-2 fps
BVO	$ \overline{\Delta V} $	-450 fps
STPZ ₁	$\Delta \Psi_A$	5×10^{-7} rad
STPZ ₂	$\Delta \gamma_A$	5×10^{-7} rad
STPZ ₃	ΔV_A	1×10^{-7} er/hr
STPZ ₄	T_A	1×10^{-7} hr
STPZ ₅	T_R	1×10^{-7} hr
STPZ ₆	ΔV_X	1×10^{-7} er/hr
STPZ ₇	ΔV_Y	1×10^{-7} er/hr
STPZ ₈	ΔV_Z	1×10^{-7} er/hr
STPZ ₉	$\Delta \gamma_A$ (optimise setup)	1×10^{-6} rad
STPZ ₁₀	ΔV_A (optimise setup)	5×10^{-7} er/hr
IWGT ₁	$\Delta \Psi_A$	1
IWGT ₂	$\Delta \gamma_A$	1

TABLE VI.- VALUES FOR GENERALIZED ITERATOR CONSTANTS - Concluded

Constant tape symbol	Associated iterator variable	Value
IWGT ₃	$\Delta\gamma_A$ (optimise setup only)	4
IWGT ₄	ΔV_A	16
IWGT ₅	ΔV_A (optimise setup only)	1
IWGT ₆	T_A (standard setup)	64
IWGT ₇	T_A (RTED)	1
IWGT ₈	T_R	1
IWGT ₉	ΔV_X	1
IWGT ₁₀	ΔV_Y	1
IWGT ₁₁	ΔV_Z	1

TABLE VII.- CONIC SUBPROCESSOR

Symbol	Value
(a) Earth-centered subprocessor	
δT	2 hr
a	77.0 hr
b	+6.2 hr/er
c	-0.103333 hr/er ²
T_{RZAVE}	0.17 hr
η_{RZAVE}	0.5 rad
(b) Moon-centered subprocessor	
ΔT_Z	120 hr

TABLE VIII.- PREFLIGHT PARAMETERS FOR LOI PROCESSOR

Symbol	Definition
H_{lo}	Nominal LPO circular orbit altitude referenced to the LLS
H_{ac}	Nominal LPO elliptical orbit apocynthion altitude referenced to the LLS
T_{biaseo}	Time bias to compensate for elliptical LPO
ϕ_{lls}^a	Latitude of LLS
λ_{lls}^a	Longitude of LLS
R_{lls}^a	Radius of LLS
$\begin{matrix} m \\ n \end{matrix} \}$	Numbers used to compute CSM plane change
$\Delta V_{loi\ cal}$	Calibration of conic LOI ΔV
$\Delta V_{tei\ cal}$	Calibration of conic TEI ΔV
c	First guess on Lambert guidance constant
Transfer angle	Transfer angle from LOI impulsive point to Lambert target vector
H_{rnty}	Nominal value for height of reentry
I_{pr}^a	Nominal value for inclination of powered return
T_{te}^a	Nominal transearth flight time
T_{lo}^a	Time in lunar parking orbit
ΔT_{lls}^a	Delta time to first pass over LLS
ΔV_{tei}^a	Delta velocity at TEI

^aThe parameters are on the MCC preflight data tape.

TABLE VIII.- PREFLIGHT PARAMETERS FOR LOI PROCESSOR - Concluded

Symbol	Definition
$\Delta\psi_{tei}^a$	Delta azimuth at TEI
GMT_{pc}^a	Greenwich mean time of pericynthion measured from epoch

^aThe parameters are on the MCC preflight data tape.

TABLE IX.- LOI PREFLIGHT DATA NOT CONTAINED IN
MCC PROCESSOR DATA TABLES

Symbol	Value
H_{lo}	60 n. mi.
H_{ac}	170 n. mi.
T_{bias}	.332 hr
m	1
n	0
$\Delta V_{loi\ cal}$	5 fps
$\Delta V_{tei\ cal}$	90 fps
c	.5
Transfer angle	270 deg
H_{rnty}	400 000 ft

TABLE X.- PREFLIGHT CONSTANTS (DATA) - (POWERED FLIGHT PROCESSOR - IGM)

Parameter	Definition	Value
$K_{\alpha 1}, K_{\alpha 2}$	coefficients of α_{TS} polynomial	0, 0
DTGM	time from TB6 to time at which IGM guidance is initiated	584.0 sec
DTIG	time from TB6 to time at which ignition occurs	577.8 sec
K_{po}, K_{yo}	coefficients in pitch, yaw polynomials	90.0, 0.0 deg
K_{T3}	coefficient in T_3 polynomial	0.0
T_2	second guidance stage burn time	0.0 sec
t_{b2}	transition time for mixture ratio shift	1.0 sec
K_{pc}	constant used to force MRS in IGM	0.0 sec
ϵ_1	remaining burn time for which alternate method of computing range angle is used	1000. sec
ϵ_2	remaining burn time for which guidance enforces only terminal velocity conditions	30. sec
ϵ_3	remaining burn time for which terminal r, v, γ are frozen	30. sec
ϵ_4	remaining burn time at which cutoff equations are entered	3. sec
R ϕ T	flag which indicates rotation of end conditions	1.0
R ϕ V	constant used for biasing terminal range angle prediction	-0.4
\dot{x}_{YL}	maximum allowable pitch rate	1.0 deg/sec
\dot{x}_{ZL}	maximum allowable yaw rate	1.0 deg/sec
\dot{x}_{XL}	maximum allowable roll rate	1.0 deg/sec
C'_o	time artificial tau mode is used, measured from time IGM is initiated	10.0 sec
ΔT_{4M}	limited value for difference between actual and nominal burn times for first S-IVB burn	100.0 sec
v_{EX3}	exhaust velocity, third IGM stage	4.1835690 km/sec

TABLE X.- PREFLIGHT CONSTANTS (DATA) - (POWERED FLIGHT PROCESSOR - IGM) - Continued

Parameter	Definition	Value
\dot{M}_3	mass flow rate, third IGM stage S-IVB engine model	217.6286 kg/sec
T_0	time from TB6 to start of first thrusting phase (vent and ullage)	0.0 sec
T_1	time from TB6 to start of second thrusting phase (chilldown)	570.0 sec
T_2	time from TB6 to start of third thrusting phase (buildup)	577.8 sec
T_3	time from TB6 to start of fourth thrusting phase (constant PU setting)	581.4 sec
T_4	time from TB6 to start of fifth thrusting phase (main burn)	583.4 sec
DTT	delta time from cutoff for J2 tailoff (plus some LH2 vent) phase	2.0 sec
DTV	delta time for LH2 vent	540.0 sec
TH0	thrust level in first phase	47.0 lb
TH1	thrust level in second phase	1085.0 lb
TH2	thrust level in third phase	89 353.0 lb
TH3	thrust level in fourth phase	180 519.0 lb
TH4	thrust level in fifth phase (1st opp)	201 967.0 lb
TH4	thrust level in fifth phase (2nd opp)	201 710.0 lb
THTO	thrust level in tailoff phase	26 130.0 lb
THV	thrust level in tailoff vent phase	12.0 lb
MFO	mass flow rate, first phase	.11 lb/sec
MF1	mass flow rate, second phase	3.72 lb/sec

TABLE X.- PREFLIGHT CONSTANTS (DATA) - (POWERED FLIGHT PROCESSOR - IGM) - Concluded

Parameter	Definition	Value
MF2	mass flow rate, third phase	181.67 lb/sec
MF3	mass flow rate, fourth phase	435.50 lb/sec
MF4	mass flow rate, fifth phase (1st opp)	477.92 lb/sec
MF4	mass flow rate, fifth phase (2nd opp)	477.77 lb/sec
MFT0	mass flow rate, tailoff phase	16 lb/sec
MFV	mass flow rate, tailoff vent phase	.31 lb/sec

APPENDIX

TAPE FORMAT FOR THE POWERED-FLIGHT PROCESSOR

TABLE A-I.- MSFC PRESENT TAPE FORMAT

Tape position	Symbol	Units	Definition (reference)
1		days	Launch day
2		months	Launch month
3		years	Launch year
4		sec	Reference launch time (midnight)
5	TLO RAO (θ_{EO})	deg	Reference launch site right ascension (positive east of vernal equinox)
6			Blank
7			Blank
8 - 60	A_z	deg	Table of values for launch azimuth from analytic launch azimuth model
61 - 113	t_D	sec	Table of values for t_D corresponding to values of A_z
114 - 128	RAS_1	deg	15-place table of target vector right ascension, first TLI opportunity
129 - 143	DEC_1	deg	15-place table of target vector declination, first TLI opportunity
144 - 158	$C3_1$	km^2/sec^2	15-place table of target $C3_1$ (twice specific energy at TLI), first TLI opportunity

TABLE A-I.- MSFC PRESENT TAPE FORMAT - Continued

Tape position	Symbol	Units	Definition (reference)
159 - 173	$\cos \sigma_1$		15-place table of values of $\cos \sigma_1$, first TLI opportunity
174 - 188	e_{N_1}		15-place table of values of e_{N_1} , first TLI opportunity
189 - 190			Blank
191 - 205	RAS_2	deg	Table of values of target vector right ascension, second TLI opportunity
206 - 220	DEC_2	deg	Table of values of target vector declination, second TLI opportunity
221 - 235	$C3_2$	km^2/sec^2	Table of values of $C3_2$ (twice specific energy at TLI), second TLI opportunity
236 - 250	$\cos \sigma_2$		Table of values of $\cos \sigma_2$, second TLI opportunity
251 - 265	e_{N_2}		Table of values of e_{N_2} , second TLI opportunity
266			Number of azimuths
267			Blank

TABLE A-I.- MSFC PRESENT TAPE FORMAT - Continued

Tape position	Symbol	Units	Definition (reference)
268 - 282	t_D	sec	Table of values of t_D , independent variable for all out-of-orbit targeting tables, both TLI opportunities
283	α_{TS_1}	deg	Angle between \hat{S} and \hat{T} at S-IVB reignition, first opportunity
284	β_1	deg	Angle between \hat{S} and \hat{R}_i at initiation of S-IVB restart preparations, first opportunity
285	R_{N_1}	ft	Nominal reignition radius, first opportunity
286	T_{ST_1}	sec	Constant used to initiate the $\bar{S} \cdot \bar{T}_p$ test, first opportunity
287	f_1	deg	True anomaly of the predicted cutoff radius vector, first opportunity
288	T'_{3R}	sec	Initial prediction of fifth stage (IGM) burn time, first opportunity
289	τ_{3R}	sec	Estimated time to deplete vehicle mass from assumed MRS, first opportunity
290	ΔV_{BR1}	m/sec	Velocity cutoff bias for translunar injection, first opportunity

TABLE A-I.- MSFC PRESENT TAPE FORMAT - Continued

Tape position	Symbol	Units	Definition (reference)
291, 292			Blank
293	α_{TS_2}	deg	Angle between \hat{S} and \hat{T} at S-IVB reignition, second opportunity
294	β_2	deg	Angle between \hat{S} and \hat{R}_1 at initiation of S-IVB restart preparations, second opportunity
295	R_{N2}	ft	Nominal reignition radius, second opportunity
296	T_{ST2}	sec	Constant used to initiate the $\bar{S} \cdot \bar{T}_p$ test, second opportunity
297	f_2	deg	True anomaly of the predicted cutoff radius vector, second opportunity
298	T'_{3R2}	sec	Initial prediction of fifth stage (IGM) burn time, second opportunity
299	τ_{3R2}	sec	Estimated time to deplete vehicle mass from assumed MRS, second opportunity
300	ΔV_{BR2}	m/sec	Velocity cutoff bias for translunar injection, first opportunity
301 - 303			Blank

TABLE A-I.- MSFC PRESENT TAPE FORMAT - Continued

Tape position	Symbol	Units	Defintion (reference)
a ₃₀₄	AZO	deg	Initial value of launch azimuth used as independent variable in forming the polynomials for i and θ_N
305	AZS	deg	Range of launch azimuth values used in forming the polynomials for i and θ_N
306 - 312	f ₀ , f ₁ , f ₆		Coefficients of polynomial for i
313 - 319	g ₀ , g ₁ , g ₆		Coefficients of polynomial for θ_N
320 - 324	h ₁₀ , h ₁₁ , h ₁₄		Coefficients of first launch azimuth polynomial segment
325 - 329	h ₂₀ , h ₂₁ , h ₂₄		Coefficients of second launch azimuth polynomial segment
330 - 334	h ₃₀ , h ₃₁ , h ₃₄		Coefficients of third launch azimuth polynomial segment

^aData in tape positions 304 through 346 are not used by the Powered-Flight Processor.

TABLE A-I.- MSFC PRESENT TAPE FORMAT - Concluded

Tape position	Symbol	Units	Definition (reference)
335	t_{DS1}	sec	Time of closing of the first launch azimuth segment and opening of the second segment
336	t_{DS2}	sec	Time of closing of the second launch azimuth segment and opening of the third segment
337	t_{DS3}	sec	Time of the closing of the third launch azimuth segment
338	t_{D1}	sec	Actual time of launch minus referenced time of launch (TLO) opening of first azimuth polynomial segment
339	t_{D2}	sec	t_D at opening of second azimuth polynomial $t_{D2} = t_{DS1}$
340	t_{D3}	sec	Value of t_D at opening of third azimuth polynomial $t_{D3} = t_{DS2}$
341	t_{SD1}	sec	t_D increment over first azimuth polynomial segment = t_{DS1}
342	t_{SD2}	sec	t_D increment over second polynomial segment = $t_{DS2} - t_{DS1}$
343	t_{SD3}	sec	increment third segment = $t_{DS3} - t_{DS2}$
344 - 346			Blank

MSC CARD FORMAT

1. All numbers will be right justified in the field (except the ID which will be left justified).
 2. All numbers except launch day and opportunity will be in a form such as X.XXXXXXXX or X.XXXXXXXX±XXX.
 3. If there are no parameters for a launch day or opportunity, then all fields should be zero.
 4. The values of t_D will be in ascending order.
 5. Identification field:

XX	XXX	X	XXX
year	day of year	opportunity	card number

TABLE A-II.- CARD FORMAT

Card no	Column					
1	1 - 17	18 - 34	35 - 51	52 - 68	69 - 80	
2	Launch day of year	Opportunity	t_D	$\cos \sigma$	XXXXXXX	Identification
3	c_3	e_n	RA	DEC	XXXXXXX	
4	t_D	$\cos \sigma$	c_3	e_n	XXXXXXX	Identification
5	er^2/hr^2	Hours	er^2/hr^2			
6 - 23	RA	DEC	t_D	$\cos \sigma$	XXXXXXX	The format of cards 3, 4, and 5 will be repeated in cards 6 - 23.
24 - 46	Radians	Radians	Hours			Same format as cards 1 - 23 except for the same launch day and second opportunity.
47 - 92	c_3	e_n	RA	DEC	XXXXXXX	Same format as cards 1 - 46 except for second launch day.
93 - 138	er^2/hr^2	Radians	Radians	Identification		Same format as cards 1 - 46 except for third launch day.

TABLE A-II. - CARD FORMAT - Continued

Card no	Column					
139 - 184	Same format as cards 1 - 46 except for fourth launch day.					
185 - 230	Same format as cards 1 - 46 except for fifth launch day.					
231 - 276	Same format as cards 1 - 46 except for sixth launch day.					
277 - 322	Same format as cards 1 - 46 except for seventh launch day.					
323 - 368	Same format as cards 1 - 46 except for eighth launch day.					
369 - 414	Same format as cards 1 - 46 except for ninth launch day.					
415 - 460	Same format as cards 1 - 46 except for tenth launch day.					
461	<table border="1"> <tr> <td>Launch day of year</td> <td>Opportunity</td> <td>T_{ST}</td> <td>β</td> <td>XXXXXX</td> </tr> </table>	Launch day of year	Opportunity	T_{ST}	β	XXXXXX
Launch day of year	Opportunity	T_{ST}	β	XXXXXX		
462	<table border="1"> <tr> <td>α_{TS}^*</td> <td>f</td> <td>R_N</td> <td>T_3'</td> <td>XXXXXX</td> </tr> </table>	α_{TS}^*	f	R_N	T_3'	XXXXXX
α_{TS}^*	f	R_N	T_3'	XXXXXX		
463	<table border="1"> <tr> <td>τ_{3R}</td> <td>T_2</td> <td>V_{ex2}</td> <td>M_2</td> <td>XXXXXX</td> </tr> </table>	τ_{3R}	T_2	V_{ex2}	M_2	XXXXXX
τ_{3R}	T_2	V_{ex2}	M_2	XXXXXX		
464	<table border="1"> <tr> <td>ΔV_{BR}</td> <td>τ_{2N}</td> <td>K_{p0}</td> <td>K_{y0}</td> <td>XXXXXX</td> </tr> </table>	ΔV_{BR}	τ_{2N}	K_{p0}	K_{y0}	XXXXXX
ΔV_{BR}	τ_{2N}	K_{p0}	K_{y0}	XXXXXX		

TABLE A-II.- CARD FORMAT - Continued

Card no	Column															
465 - 468	Same format as cards 461 - 464 except for same launch day and second opportunity.															
469 - 476	Same format as cards 461 - 468 except for second launch day.															
477 - 484	Same format as cards 461 - 468 except for third launch day.															
485 - 492	Same format as cards 461 - 468 except for fourth launch day.															
493 - 500	Same format as cards 461 - 468 except for fifth launch day.															
501 - 508	Same format as cards 461 - 468 except for sixth launch day.															
509 - 516	Same format as cards 461 - 468 except for seventh launch day.															
517 - 524	Same format as cards 461 - 468 except for eighth launch day.															
525 - 532	Same format as cards 461 - 468 except for ninth launch day.															
533 - 540	Same format as cards 461 - 468 except for tenth launch day.															
1 - 17	18 - 34 35 - 51 52 - 68 69 - 80															
541	<table border="1"> <thead> <tr> <th>Launch day of year</th> <th>T_{LO}</th> <th>θ_{EO}</th> <th>ω_e</th> <th>Identification</th> </tr> <tr> <th>Hours</th> <th>Radians</th> <th>rad/hr</th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>K_{α1}</td> <td>K_{α2}</td> <td>K_{T3}</td> <td>t_{DSO}</td> <td>XXXXXXX</td> </tr> </tbody> </table>	Launch day of year	T _{LO}	θ_{EO}	ω_e	Identification	Hours	Radians	rad/hr			K _{α1}	K _{α2}	K _{T3}	t _{DSO}	XXXXXXX
Launch day of year	T _{LO}	θ_{EO}	ω_e	Identification												
Hours	Radians	rad/hr														
K _{α1}	K _{α2}	K _{T3}	t _{DSO}	XXXXXXX												
542	<table border="1"> <thead> <tr> <th>rad/hr</th> <th>rad/hr²</th> <th>Hours</th> <th>Identification</th> </tr> </thead> </table>	rad/hr	rad/hr ²	Hours	Identification											
rad/hr	rad/hr ²	Hours	Identification													

TABLE A-II.— CARD FORMAT — Continued

Card no	Column					
543	1 - 17 18 - 34 35 - 51 52 - 68 69 - 80 <table border="1"> <tr> <td>t_{DS1}</td> <td>t_{DS2}</td> <td>t_{DS3}</td> <td>h_{10}</td> <td>XXXXXXX</td> </tr> </table>	t_{DS1}	t_{DS2}	t_{DS3}	h_{10}	XXXXXXX
t_{DS1}	t_{DS2}	t_{DS3}	h_{10}	XXXXXXX		
544	Hours Hours Radians Identification <table border="1"> <tr> <td>h_{11}</td> <td>h_{12}</td> <td>h_{13}</td> <td>h_{14}</td> <td>XXXXXXX</td> </tr> </table>	h_{11}	h_{12}	h_{13}	h_{14}	XXXXXXX
h_{11}	h_{12}	h_{13}	h_{14}	XXXXXXX		
545	Radians Radians Radians Identification <table border="1"> <tr> <td>t_{D1}</td> <td>t_{SD1}</td> <td>h_{20}</td> <td>h_{21}</td> <td>XXXXXXX</td> </tr> </table>	t_{D1}	t_{SD1}	h_{20}	h_{21}	XXXXXXX
t_{D1}	t_{SD1}	h_{20}	h_{21}	XXXXXXX		
546	Hours Hours Radians Radians Identification <table border="1"> <tr> <td>h_{22}</td> <td>h_{23}</td> <td>h_{24}</td> <td>t_{D2}</td> <td>XXXXXXX</td> </tr> </table>	h_{22}	h_{23}	h_{24}	t_{D2}	XXXXXXX
h_{22}	h_{23}	h_{24}	t_{D2}	XXXXXXX		
547	Radians Radians Hours Identification <table border="1"> <tr> <td>t_{SD2}</td> <td>h_{30}</td> <td>h_{31}</td> <td>h_{32}</td> <td>XXXXXXX</td> </tr> </table>	t_{SD2}	h_{30}	h_{31}	h_{32}	XXXXXXX
t_{SD2}	h_{30}	h_{31}	h_{32}	XXXXXXX		
548	Hours Radians Radians Identification <table border="1"> <tr> <td>h_{33}</td> <td>h_{34}</td> <td>t_{D3}</td> <td>t_{SD3}</td> <td>XXXXXXX</td> </tr> </table>	h_{33}	h_{34}	t_{D3}	t_{SD3}	XXXXXXX
h_{33}	h_{34}	t_{D3}	t_{SD3}	XXXXXXX		
549 - 556	Same format as cards 541 - 548 except for second launch day.					
557 - 564	Same format as cards 541 - 548 except for third launch day.					

TABLE A-II.- CARD FORMAT - Concluded

Card no	Column
565 - 572	Same format as cards 541 - 548 except for fourth launch day.
573 - 580	Same format as cards 541 - 548 except for fifth launch day.
581 - 588	Same format as cards 541 - 548 except for sixth launch day.
589 - 596	Same format as cards 541 - 548 except for seventh launch day.
597 - 604	Same format as cards 541 - 548 except for eighth launch day.
605 - 612	Same format as cards 541 - 548 except for ninth launch day.
613 - 620	Same format as cards 541 - 548 except for tenth launch day.

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1. Morrey, Bernard F.; McCaffety, Brody O.; and Morrey, Alfred E.: RTCC Requirements for Mission G: The Translunar Midcourse Correction Processor. MSC IN 68-FM-193, August 9, 1968.
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3. Wiley, Robert F.: RTCC Requirements for Mission G: LOI Processor. MSC IN 68-FM-132, July 18, 1968.
4. Davis, Robert S.; and Lee, W. R.: AS-503/504 Requirements for the RTCC: The Return-To-Earth Abort Processor, Volume I - Earth-Centered Logic. MSC IN 67-FM-199, December 15, 1967.
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